Greetings and welcome to the **FEBRUARY 2016** edition of the WDFW Climate News Digest. The purpose of this newsletter is to provide highlights of relevant climate change news, events and resources for WDFW staff. Feedback or suggestions for items to include in future editions are much appreciated – many *thanks* to those who have sent links and references and please keep them coming.

Thanks for contributions this month from, Derek Stinson, Larry Dominguez, Michael Cox (EPA), Bruce Botka, and John Mankowski (NPLCC).
Other sources for news include: Point Blue Conservation Science, NPLCC Climate Science Digest, Climate.gov, NOAA's Climate Newsletter, and "BioClimate", the newsletter of the USGS Climate Science Centers. See the end of this email for a list of climate-related listservs in the event you'd like to subscribe directly.

WHAT'S HAPPENING AT WDFW?

Are you working on a project that may be affected by climate change? Have you considered or included climate change in research proposals, workshops or other activities? Please be in touch to share your news or experience!

CLIMATE ADAPTATION AT OTHER ORGANIZATIONS

The Federal Highway Administration and Climate Change

State and regional transportation agencies across the country are facing extreme weather events that damage roads and bridges and cost large sums to repair, not to mention the cost to the economy from disrupted travel. Extreme weather events - including heat waves, drought, tropical storms, high winds, storm surges and heavy downpours - are becoming more frequent and severe as the climate changes. These climate risks threaten the considerable federal investment in transportation infrastructure and FHWA is responding:

- FHWA issued an order committing the agency to integrating climate risk considerations into the delivery and stewardship of FHWA programs.
- Climate adaptation activities are eligible for FHWA funding, including vulnerability assessments and design and construction of projects or features to protect assets from damage associated with climate change.
- FHWA developed tools and guidance for systematic consideration of climate risks at transportation system and project levels.

See more **here:**

Opportunity to provide input to British Columbia's Climate Leadership Plan

Now through March 25th, British Columbians will have an opportunity to participate in the second public consultation on the development of B.C.'s new Climate Leadership Plan. Citizens, First Nations, local governments, and organizations are encouraged to participate in this 60-day engagement process through the Climate Leadership Plan website.

RESOURCES

See Before-and-After Photos of the Changing Environment *(from National Geographic)*

Side-by-side comparisons reveal just how much glaciers, lakes, and snowpacks have been altered by nature and humans.

Massachusetts Wildlife Climate Action Tool
This tool is designed so that users can look up different species and habitat types to see what beneficial climate actions they can take. Entries include brook trout, which are impacted by warming stream temperatures and fragmented habitat; marbled salamander, which are impacted by changing rainfall patterns; moose, which are at the southern end of their range; blackpoll warbler, which are vulnerable to changing forest habitat conditions; and beech-birch-maple forests, where warming temperatures impact sugar maples and other northern trees.

Climate Change and Regional Impacts
This module is an overview of the different effects climate change produces in different regions of the United States. In addition to discussing impacts already being experienced, the module presents information on how climate scientists use specialized models and statistical techniques to estimate how regional climates are likely to change in the future

Snow and Ice Cover
Daily maps show the extent of snow cover (and ice) over the contiguous United States, Alaska, or the whole Northern Hemisphere. Images are embedded in an animation tool that allows users to view daily changes and seasonal trends.

Climate Change Vulnerability and Adaptation in the Blue Mountains Region
A new report from the Blue Mountains Adaptation Partnership (BMAP) identifies climate change issues relevant to resource management in the Blue Mountains Region and offers solutions to help transition the region into a warmer climate. The BMAP is a science-management partnership composed of Malheur National Forest, Umatilla National Forest, Wallowa-Whitman National Forest, the U.S. Forest Service Pacific Northwest Research Station and Pacific Northwest Region, the University of Washington, and the Climate Impacts Research Consortium at Oregon State University. This report summarizes effects of climate change on the streamflow and snowpack of the Blue Mountains Region, and projects the impact these changes will have on the region's ecosystem.

Sea Level Rise and Coastal Flood Web Tools Comparison Matrix *(from Climate.gov)*
This matrix helps coastal management communities compare web-based sea level rise and coastal flood risk tools available for their state. The matrix describes features of each tool and the methods behind the data they present. The expandable/collapsible matrix offers comparisons of the tools in six main categories. Descriptions for each tool come directly from the tool's owners. The matrix also includes a point of contact for each tool, giving potential users a direct way to get specific questions answered.

LEARNING OPPORTUNITIES

February 10th, 11:00 AM (Pacific), webinar, "Completing the Loop; Combining Occupancy Modeling, Crowd-sourcing, and eDNA Sampling to Inventory Bull Trout". Presenter, Mike Young, USFS Rocky Mountain Research Station. Interest in using environmental DNA (eDNA) sampling to monitor aquatic species is exploding. This technique makes it possible to conduct rapid and cost-effective broad-scale species assessment and monitoring, particularly when informed by robust species distribution models. Here, we provide preliminary results from an effort to identify habitats occupied by juvenile bull trout in basins constituting their historical U.S. range.

February 11th, 10:00-11:00 AM (Pacific), webinar, "Maps and Datasets for Blue Carbon Habitats"
Blue carbon denotes the long-term storage of carbon within plant habitats growing in coastal lands and nearshore marine environments. With support from the Commission for Environmental Cooperation, maps of blue carbon habitats- seagrass, salt marsh, and mangroves- on the coasts of Canada, Mexico and the United States were collected, verified and compiled to create the first continent-wide collection of blue carbon habitat maps. A geodatabase was established, metadata were documented, and data and methodological gaps were assessed along with challenges in identifying the extent of these habitats. Webinar co-sponsored by the NOAA National Marine Protected Areas Center, MPA News, OpenChannels.org, and the EBM Tools Network. Register here

February 11th, 11:00 AM (Pacific), webinar, "Climate Change in America's National Parks: Bird Conservation in a Changing Climate"
National Audubon Society scientists recently completed a comprehensive analysis modeling the winter and summer ranges of 588 North American bird species in response to future climate change. Using citizen science data and climate layers, these models characterize the relationship between the distribution of each species and climate through the end of the century. Chad Wilsey will talk about the results and the implications for conservation.

February 24th, 12:30 (Pacific), webinar: "Forecasting Potential Climate Refugia to Guide Conservation of Montane Species"
This talk will review a landscape modeling project to predict climate refugia for montane spruce-fir forests in the Green Mountain National Forest in Vermont using LANDIS-II. We've developed new maps of forest composition and soil properties for this National Forest to generate the most realistic starting conditions for projections of change under future climate. Register here.

March 3rd, 11:00-12:00 (Pacific), webinar: "Planning for connectivity on national forests under the 2012 Planning Rule"
The 2012 Forest Service Planning Rule guides the management of national forest lands through the preparation and implementation of forest plans. The 2012 Planning Rule includes direction for managing for ecological connectivity on national forest lands and facilitating connectivity planning across land ownerships – the first such requirements in the history of U.S. public land management. This presentation summarizes information on the role of connectivity within the conservation framework of the 2012 Planning Rule and presents recommendations and examples of how to develop effective connectivity conservation strategies within the forest planning process.

March 9-11th, 2016, Workshop, Kennewick, Wa, "**Agriculture in a Changing Climate Workshop**"
Washington State University's Center for Sustaining Agriculture & Natural Resources (CSANR), USDA Northwest Regional Climate Hubs, and the Regional Approaches to Climate Change for Pacific Northwest Agriculture (REACCH) team invite you to participate in this upcoming workshop. There will be dedicated mitigation and adaptation sessions, with an overlapping poster networking event. Each session will feature guest speakers, panel discussions, and breakout sessions. Registration opening soon. Limited spots available

April 6th, 12:30 (Pacific), webinar, "Patterns, Causes and Consequences of Spring Onset Timing Variations and Trends in the U.S."
Julio Betancourt, National Research Program, USGS. Seasonal timing has myriad impacts on plants and animals, biospheric processes, and human systems, and is critical for formulating adaptive responses to both climate variability and change. In the U.S., and especially, the timing of seasonal transitions varies widely from year to year and is also changing directionally, yet the climatic drivers, patterns, and

consequences of these variations are not well understood. This webinar will discuss day-of-year (DOY) metrics that define spring onset in the U.S. Read more and register here »

April 26th, 2016, Workshop, Vancouver, WA, "Introducing the Southwest Washington Climate Change Vulnerability Assessment"
The purpose of this workshop is to influence climate change adaptation planning on the Gifford Pinchot National Forest. Adaptation options developed at the workshop will be incorporated into the Southwest Washington Climate Change Vulnerability Assessment and will help resource specialists and other interested parties understand, mitigate, and adapt to effects of climate change on natural resources. RSVP: Please notify Jessica Hudec (jhudec@fs.fed.us or 509-395-3403) if you plan to attend so we can be sure to reserve an appropriately sized meeting space.

Recorded Webinar: How Identifying Climate Refugia can help to Prioritize conservation
In this presentation, Toni Lyn Morelli summarizes the physical processes that create climate refugia, discusses a new framework for locating and managing them, and uses examples to illustrate ways to identify and verify climate refugia. She highlights her research using historical comparisons, genetic data, and surveys of Belding's ground squirrels in the Sierra Nevada to conduct a rare test to determine which montane meadows are acting as refugia to buffer wildlife populations from climate change. Focusing on climate refugia could be an important strategy to help managers prioritize habitats for conservation in a changing climate.

2015 Northwest Climate Conference – videos now available here
Presentation videos from November's NWCC are now available. These videos are also linked from the web version of the conference program available from the conference website homepage http://pnwclimateconference.org. The 2016 Northwest Climate Conference is being planned for this fall in Oregon – details to be posted in this newsletter as they are available.

CLIMATE SCIENCE NEWS

January Newsletter from the Office of Washington State Climatologist (attached)
Topics include: monthly climate summary, snowpack and drought update, early winter conditions and El Nino, temperature and precipitation outlook

No surprise, 2015 sets new global temperature record *(from Climate.gov)*
NOAA Scientists confirmed 2015 to be the warmest year on record, according to this press release: "During 2015, the average temperature across global land and ocean surfaces was 1.62°F (0.90°C) above the 20th century average. This was the highest among all years in the 1880-2015 record, surpassing the previous record set last year by 0.29°F (0.16°C). This is also the largest margin by which the annual global temperature record has been broken. Ten months had record high temperatures for their respective months during the year. The five highest monthly departures from average for any month on record all occurred during 2015. Since 1997, which at the time was the warmest year on record, 16 of the subsequent 18 years have been warmer than that year."

ENSO Blog; January El Niño update: It's got a lot going on *(from Climate.gov)*
A blog about monitoring and forecasting El Niño, La Niña, and its impacts

Climate and land cover effects on the temperatures of Puget Sound streams

From the abstract: This study applies "an integrated hydrology-stream temperature modeling system, DHSVM-RBM, to examine the response of the temperature of the major streams draining to Puget Sound to land cover and climate change. We first show that the model construct is able to reconstruct observed historic streamflow and stream temperature variations at a range of time scales. We then explore the relative effect of projected future climate and land cover change, including riparian vegetation, on streamflow and stream temperature. Streamflow in summer is likely to decrease as the climate warms especially in snowmelt-dominated and transient river basins despite increased streamflow in their lower reaches associated with urbanization. Changes in streamflow also result from changes in land cover, and changes in stream shading result from changes in riparian vegetation, both of which influence stream temperature. However, we find that the effect of riparian vegetation changes on stream temperature is much greater than land cover change over the entire basin especially during summer low flow periods. Furthermore, while future projected precipitation change will have relatively modest effects on stream temperature, projected future air temperature increases will result in substantial increases in stream temperature especially in summer. These summer stream temperature increases will be associated both with increasing air temperature, and projected decreases in low flows. We find that restoration of riparian vegetation could mitigate much of the projected summer stream temperature increases".

SPECIES AND HABITATS

West Coast study emphasizes challenges faced by marine organisms exposed to global change

(from NPLCC Climate Science Digest)

Physiological changes that are common to many marine taxa can be a useful measurement when applying regional research to global change. A new study published in BioScience examined certain physiological changes to marine taxa off the West Coast of the U.S. in order to develop a global model for how other areas of the ocean could respond to future warming, acidification, and low dissolved oxygen concentrations (hypoxia). The West Coast displayed all three of these ocean stressors, making it a valuable study area for understanding how a multiple-stressor ocean will impact its ecosystem. The team of scientists synthesized dozens of studies analyzing various physiological responses to these three ocean stressors and found that physiological changes in marine organisms can lead to changes in animal behavior, biogeography, and ecosystem structure.

The Voice of the Canaries in the Coal Mine: West Coast Shellfish Industry Responds to Ocean Acidification *(from NPLCC Climate Science Digest)*

The U.S. West Coast shellfish industry continues to be one of the first to feel the effects of climatic extremes, and therefore knows the economic damage these events can have on its livelihood. Ocean acidification was pegged as the dominant factor that led to past declines in shellfish populations, so scientists from Oregon State University decided to survey the shellfish industry to measure their concern toward this indirect effect of increased carbon dioxide in the atmosphere. Scientists surveyed 86 members of shellfish industries stationed in either Washington, Oregon, or California.

Anticipated Effects of Climate Change on Coastal Upwelling Ecosystems *(from NPLCC Climate Science Digest)*

A new study published as part of the collection, *Ecological Impacts of Climate Change*, discussed the projected physical changes and biological responses of four coastal upwelling zones due to increased greenhouse gases in the atmosphere. Bakun et al. (2015) used existing research to review four upwelling zones that occur on the eastern boundary of the Atlantic and Pacific Ocean basins. The review was built as a framework of predicted ecological changes that could be used to understand future measured changes to these systems.

Birds Try to Dodge Climate Change in a Surprising Way *(from NPLCC Climate Science Digest)*
A recent study, published in *Global Change Biology,* identifies the unusual movement of birds as they respond to climate change. Bateman et al. quantified the pace and direction of change for various bird species' suitable climate space over the past 60 years. The results revealed new and surprising knowledge of how birds are reacting to a changing climate. Many birds were found to be shifting ranges at twice the speed formerly assumed. In addition to this unexpected drifting pace, the majority of species' distribution shifted west, northwest, and north. This result contradicted previous predictions that birds would only shift northward. This interesting range shift direction suggested to the authors that temperature was not the sole factor influencing bird species, and that other climate conditions were also changing bird behavior.

Impacts of Biodiversity loss on climate change – and how natural "geo-engineering" can help slow warming *(from the Yale Environment 360 newsletter)*
An overlooked tool in fighting climate change is enhancing biodiversity to maximize the ability of ecosystems to store carbon. Key to that strategy is preserving top predators to control populations of herbivores, whose grazing reduces the amount of CO2 that ecosystems absorb.

Evolutionary Clock Ticks for Snowshoe Hares Facing Climate Change (*from the National Center for Climate Change and Wildlife Science)*
Snowshoe hares have evolved to camouflage themselves by changing their fur color from brown in summer to white in winter, which allows them to blend in with snow cover and hide from other animals. However, when snow comes later or leaves earlier than normal, white hares stand out to predators like "light bulbs" against a dark backdrop.
Based on an article published this week in *Ecology Letters*, changes in snow timing and duration due to climate change are deadly for snowshoe hares. White hares stand out like "light bulbs" against snowless backdrops, presenting an easy target for predators. The researchers collected data from radiocollared snowshoe hares in Montana and found that mismatched hares suffer a 7 percent drop in their weekly survival.

Study emphasizes challenges faced by marine organisms exposed to global change *(from Science Daily)*
The Pacific Ocean along the West Coast serves as a model for how other areas of the ocean could respond in coming decades as the climate warms and emission of greenhouse gases like carbon dioxide increases. This region -- the coastal ocean stretching from British Columbia to Mexico -- provides an early warning signal of what to expect as ocean acidification continues and as low-oxygen zones expand. Now, a panel of scientists from California, Oregon and Washington has examined the dual impacts of ocean acidification and low-oxygen conditions, or hypoxia, on the physiology of fish and invertebrates. The study, published in the January edition of the journal *BioScience*, takes an in-depth look at how the effects of these stressors can impact organisms such as shellfish and their larvae, as well as organisms that have received less attention so far, including commercially valuable fish and squid.

Trout threatened by warming water, lower stream flows *(from E & E Newsletter)*
Climate is directly linked to worldwide trout abundance, according to a new study by the U.S. Geological Survey. USGS biologist Ryan Kovach and his colleagues synthesized aggregate scientific literature correlating trout abundance to variations in stream flow and temperatures on a global scale. Published in *Reviews in Fish Biology and Fisheries*, the study shows lower summer stream flows are directly linked to reduced trout growth, survival and abundance. The results were consistent among trout species regardless of their location or age. Kovach said that it was not "necessarily a shocking finding" but that the consistency of the findings was surprising.

http://link.springer.com/article/10.1007/s11160-015-9414-x

Projected Scenarios for Coastal First Nations' Fisheries Catch Potential under Climate Change: Management Challenges and Opportunities

This study uses a dynamic bioclimate envelope model to project scenarios of climate-related changes in the relative abundance, distribution and richness of 98 exploited marine fishes and invertebrates of commercial and cultural importance to First Nations in coastal British Columbia, Canada. Declines in abundance are projected for most of the sampled species under both the lower and higher emission scenarios, with poleward range shifts occurring at a median rate of 10.3 to 18.0 km decade^{-1} by 2050 relative to 2000. While a cumulative decline in catch potential is projected coastwide (-4.5 to -10.7%), estimates suggest a strong positive correlation between the change in relative catch potential and latitude, with First Nations' territories along the northern and central coasts of British Columbia likely to experience less severe declines than those to the south.

Coastal vulnerability across the Pacific dominated by El Niño/Southern Oscillation *(from NPLCC Climate Science Digest)*

A new study published in *Nature Geoscience,* examined the understudied dynamic forces that act on coastal waters during storms. These understudied physical forces include wave-driven processes, storm surges, and seasonal water level anomalies, all factors that can greatly increase coastal water levels during extreme events. Barnard et al. (2015) looked at 33 years of data (1979-2012) measuring wave climate, local water levels, and coastal change, for 48 beaches throughout the Pacific Ocean Basin.

POLICY AND MANAGEMENT - MITIGATION AND ADAPTATION

How to turn climate change nonbelievers into believers, and believers into doers

Why do some people avoid the evidence that climate change is happening, and that humans are a chief cause? Social scientists have studied "information avoidance" for years, and suggest three reasons why people avoid information. See this article for a synthesis of several social science studies.

Obama halts new leases in sweeping reform announcement *(from E & E newsletter)*

The Obama administration has frozen the leasing of federally owned coal to mining companies until it can study whether the program is a good deal for taxpayers and protective enough of the environment. Interior Secretary Sally Jewell issued an **order** calling for a programmatic environmental impact statement to analyze how the administration awards coal leases, and how environmental and public health concerns factor into the decision making process. "We haven't undertaken a comprehensive review of the program in more than 30 years, and we have an obligation to current and future generations to ensure the federal coal program delivers a fair return to American taxpayers and takes into account its impacts on climate change," Jewell said in a statement, echoing President Obama's remarks on fossil fuel management in his State of the Union address.

Management Influences on Forest Carbon Dynamics in the Puget Lowlands of Washington State *(from the NPLCC Climate Science Digest)*

In this new study, Laflower et al. examined how different management actions combined with projected changes in climate would impact the composition and productivity of Puget Lowland forests in Washington state. The authors modeled forest responses to four management regimes under five different climate scenarios. Carbon dynamics between baseline and moderate emission scenarios were found be similar to

one another. By late-century, however, under the high emission scenario climate change reduced forest productivity and decreased species richness across a large proportion of the study area. The authors also found that thinning and burning treatments increased the carbon sequestration rate under all emission scenarios. However, increased productivity with management was not sufficient to prevent an overall decline in productivity under the high emission scenario. This research suggests that the carbon dynamics in the Puget Lowlands may not experience a dramatic change under the moderate emission scenario, but that the high emission scenario may alter the successional trajectory of these forests.

CLIMATE RELATED LIST SERVES AND NEWSLETTERS

List courtesy of North Pacific Landscape Conservation Cooperative

- **Climate CIRCulator** (Oregon Climate Change Research Institute)
- **Climate Impacts Group** (Univ. Washington)
- **EPA Climate Change and Water E-Newsletter**
- **LCC list servers** (see your **LCC's website**)
- **Ocean Acidification Report**
- **OneNOAA Science Webinars**
- **North Pacific LCC Listserve** – North Pacific Tidings - important news and announcements; and Climate Science Digest - new science/information affecting natural and cultural resources.
- **LCC Network News** - Bi-monthly updates from the LCC Network
- **BioClimate News & Events from NCCWSC & the CSCs**
- **NCTC Climate Change List server** (upcoming webinars and courses): send email **danielle_larock@fws.gov**
- **Pacific Institute for Climate Solutions (PICS) (British Columbia) Climate News Scan -** a weekly summary of the major climate-change related science, technology, and policy advances of direct relevance to the BC provincial and the Canadian federal governments and more generally to businesses and civil society
- **PointBlue Weekly Ecology, Climate Change and Related e-Newsletter:** Send request to **ecohen@prbo.org**
- **PNW Tribal Climate Change Network**: Send request to **kathy@uoregon.edu**
- **US Forest Service Fish & Wildlife Research Updates**